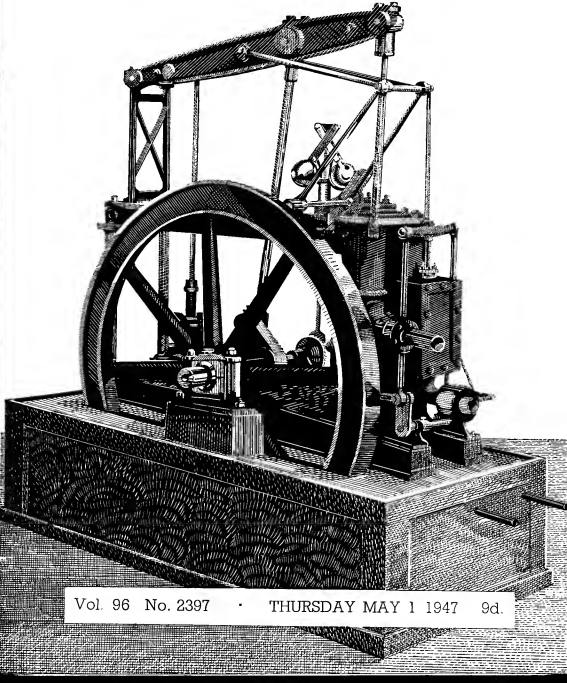
THE MODEL ENGINEER



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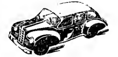
The MODEL ENGINEER

Percival Marshall & Co. Ltd., 23, Great Queen St., London, W.C.2

1 MAY 1947



VOL. 96. NO. 2397

SMOKE RINGS

Our Cover Picture

AMONG the steam engines of a past era, one of the most handsome and interesting was the "Grasshopper" type of beam engine, in which the beam, instead of being pivoted at its centre, was supported by a swinging link at one end, and connected to the piston rod at the other, and guided by the parallel motion to move in a vertical straight line at this point. Motion was transmitted to the crankshaft by a connecting-rod pivoted at an intermediate point on the beam. Engines of this type were once extensively employed for waterworks, breweries and other stationary work, besides being occasionally encountered in marine practice. The picture is based on a 1-in. scale model built by Mr. W. L. Rowson, of Skegness, which was awarded a Highly Commended Diploma at last year's MODEL ENGINEER Exhibition.

Exhibition Attractions

THE show this year has been specially planned by an architect who has adopted a blue and steel-silver colour scheme for the stands. Although there will be a number of working exhibits, the usual passenger-carrying railway track will be omitted. This is not a permanent change of plan, for we fully recognise the attraction of the "live steam" track, and it may come back again in future years. On this occasion, however, we felt that a change of interest was desirable to illustrate the wider range of model engineering activities. In place of the railway track, therefore, we have planned a special working-model circular arena, some 50 ft. in diameter, in which model racing cars, power boats, and aeroplanes will be shown in operation. It is hoped that locomotives under steam will be shown on the test-bench of the S.M. and E.E., and if space can be provided in our final floor planning, we should like to show some model traction engines at work. In this connection we should be pleased to hear from traction engine owners who would be agreeable to demonstrate their engines at intervals during the show. Enquiries from the trade for stand space are coming in well, and everything points to the 1947 show being the best-planned and most attractive exhibition we have yet held. It will open a day earlier than usual, the inclusive dates being August 20th to 30th, and the hours from 11 a.m. to 9 p.m. The admission charge will be as last year, 2s. 3d. for adults and 1s. for juniors under 16. We shall hope to meet all our friends again in this unique gathering of THE MODEL ENGINEER brotherhood. A limited space will be available for loan exhibits of special interest, and any offers of this kind will be carefully and sympathetically considered.

Exhibition Entry Forms and Prizes

THE entry forms for the competition section of our forthcoming exhibition are now ready, and may be obtained post-free on application to the Exhibition Manager, 23, Great Queen Street, London, W.C.2. Forms are being posted to all last year's competitors and to club secretaries, so that application from these supporters is not necessary unless additional forms are required. There will be five Championship Cups as follows :—(1) Steam Locomotives over

"O" gauge; (2) General Engineering Models and other Mechanical Work; (3) Steam or Motor Ships; (4) Sailing Ships; (5) Aeronautical Models. There will also be the new Cup for the best club entry of members' work. Silver and bronze medals and diplomas are offered in the various classes and this year there are separate classes for junior work and for the 5s. ingenuity work. There is no special trophy for the ladies, but of course, the work of the fair sex will be eligible for consideration in any of the classes. In addition to the official prizes, there will be a number of money-value merit prizes, to be awarded by the judges for special ingenuity or craftsmanship in any section of the competition. These prizes will be drawn from a pool formed from subscriptions generously given by friends of the Exhibition who desire that individual merit should be encouraged. This pool, in effect, replaces the special prizes privately offered in previous years for particular types of models, and will greatly simplify the allocation of such awards by the judges. Intending competitors are advised to fill in and return their forms as early as possible, as in order to provide space for a suitable display it may be necessary to decline late-comers.

A Five-Shilling Competition

A NOVEL class in the competition section of our forthcoming exhibition will be one for models or any other kind of mechanical work made from scrap or purchased material, the total cost of which does not exceed 5s. This is partly in recognition of the prevailing scarcity of materials of all kinds, and partly as a challenge to the ingenuity of our readers in "making do." I have often been impressed by the ingenious use made of "bits and pieces" in the construction of really attractive models, and I am sure that, within the cost limit imposed, some very interesting results could be obtained. It is not expected that championship models will appear in this class, but there is no reason why it should not provide some very creditable examples of a simpler kind which may appeal to those whose pockets are not too well lined or inspire the novice in the art to try his prentice hand. Models of any kind, mechanical toys, tools, or workshop or household gadgets would all come within the scope of this class, and I hope that some of my readers will be persuaded to spend a few hours in exercising their ingenuity and workshop skill in a novel direction which may prove to be of benefit to themselves, or possibly to some of their families or friends. I am sure there is a wealth of ingenuity among my readers, which if they will put their thinking caps on, should produce some surprising and possibly entertaining results.

Coventry Calling

AS will have been seen from the club report section of our April 10th issue, the Coventry Society is making progress on enterprising lines. One of the proposals under consideration is the construction of a pond for power boating, and here the society feels that it might reasonably look for some helpful co-operation from the local City authorities. To assist him in putting forward their case, their secretary, Mr. H. R. Dunkley, would be grateful if other clubs who have had the benefit of civic co-operation, would send him particulars, so that he may show how Coventry can follow the lead which has been set by the City Fathers in other important centres. There is no doubt that the communal benefits of model engineering in its various forms is being more and more widely appreciated in the Town Halls of the country, and much practical assistance and encouragement is being extended officially to the local enthusiasts. It should always be remembered that while a pond or a railway track may be primarily of benefit to the model engineers and ship modellers of the district, it is also a source of constant interest, enjoyment, and inspiration to the residents at large. Information on local official support in any town would be appreciated by Mr. H. R. Dunkley, 94, Belgrave Road, Coventry.

The Club Scribe

MY suggestion to club secretaries that they appoint a club photographer, able to take good pictures of outstanding models made by members, has, I am happy to say, been well received, and the results are now beginning to appear in the shape of some excellent pictures reaching my office. However, the model engineer seems, by nature, to have a wide streak of curiosity in his make-up. Show him a picture—he wants to hear the story, and so, as a logical development, why not appoint, in addition to a club photographer, a club scribe. It is usually the case that most of the writing is left to the poor secretary, and, generally speaking, he would, no doubt, be the best man for the job. This, however, is a matter which can only be decided by discovering the latent talent for journalism, hidden often unsuspected among club members. Articles published will, of course, be paid for at our usual rates, a fact which may help in finding someone to fill the bill.

The Late Malcolm S. Don

IT is with much regret that I learn of the passing of another of the veterans of model engineering, by the death of Mr. Malcolm S. Don, on March 28th. I knew Mr. Don for over forty years, he was a regular reader from our first issue up to the day of his death. Of a quiet and unassuming personality, he was an engineer of very wide experience, and one of the most competent experts on the design and construction of traction engines. He was a regular visitor to THE MODEL ENGINEER Exhibitions, where we always had a friendly chat, and where I found his comments on the traction engine models in the competition section most helpful in deciding the awards. His critical eye missed nothing, good or bad, in a model, and he always enjoyed the display of his favourite type of engine. He will be greatly missed by his many friends in he model engineering world.

Percival Marshall

A PRIZE-WINNING MODEL

MOTOR TANKER

by E. G. CROOKALL

AS a change from the—shall we say—home-made type of model usually described in THE MODEL ENGINEER, we publish this week an article describing a professionally made model, with a brief outline of how it was made.

The average person looking at the beautiful examples of model making to be seen in our Museums and in the windows of Shipping Companies and Travel Agencies, invariably turn aside with a feeling that such models are far beyond the ability of the ordinary craftsman. The idea seems to be that there is something akin to magic about the production of such wonderful models; our aim is to dispel this idea.

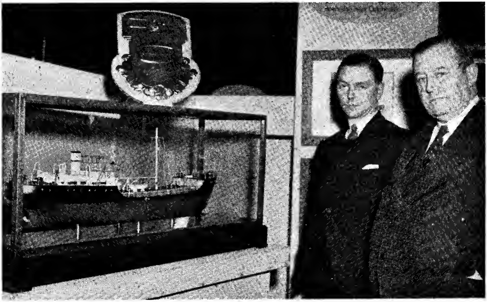
Apart from having access to a well fitted workshop and perhaps some machine tools which are beyond the reach of the average amateur, the professional is, after all, only a skilled craftsman with a little more experience than the amateur. The more intricate pieces of workmanship are usually made by hand with tools very similar to those used by the amateur. This is especially the case with ship models, as accurate boring and turning of metal parts is required to only a very limited extent. The flowing lines and graceful curves of a ship depend more on the artistic eye and taste of the modeller than on any special equipment he may have. Proof of this may be seen in many of the models at our Annual Exhibition.

So we would say to our readers, take another look at these masterpieces of the modeller's craft and, instead of considering them as being beyond your ability, use them as representing a standard to be aimed at and, eventually, by perseverance and painstaking care, to be achieved.—E.B.

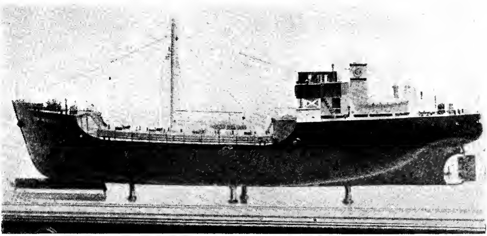
This ¼ in. scale model M.T. "Ben Hebden" won the Ayre Award at the Shipwrights' Exhibition in London last January: a bronze plaque given by Sir Amos Ayre, Prime Warden of the Worshipful Company of Shipwrights, for the best model of a coastal vessel under a thousand tons dead weight.

The original tanker, still under construction, will be a 390 ton, single-screw motor tanker, 145 ft. overall with a beam of 25 ft., for use in the coastal petroleum trade. The finished model which for exhibition purposes was installed in a mahogany-framed glass case, is 36¼ in. long; beam 6¼ in.

Work on the model M.T. "Ben Hebden" began only one month after the keel of the original tanker was laid on a slipway in Essex. Six weeks later the finished model was being



Sir Amos Ayre, right, with Mr. D. T. Oxton, (managing director of the Rowhedge Ironwork Co. Ltd.) and the model "Ben Hebden." The bronze plaque is also seen, which Sir Amos Ayre presented for the best model under 1,000 tons D.W.

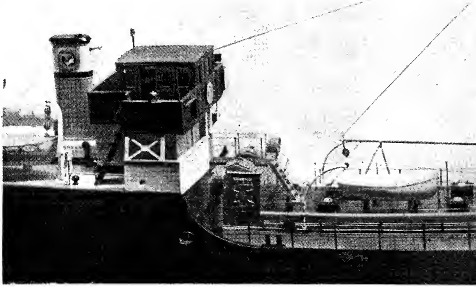


The model Motor-tanker " Ben Hebden "

duly admired by both ship-owners and ship-builders.

C. A. Mills and Associates, of Ruislip, who built the model, state that to make a prize-winning model in six weeks requires three all-important factors: firstly, three craftsmen of which Mr. Mills is the leader responsible for planning the work and final construction, while the remaining two carry out the necessary wood-work and spray-painting, and metal-work respectively; secondly, the wholehearted co-operation of the ship-builders for whom the model was built and who made available nearly one hundred and fifty working drawings and photographs; thirdly, very careful planning and working to a fixed time limit. All three craftsmen are partners in the business and needless to say with such an exacting job on hand, no time could be lost by mistakes in construction or catching a sleeve in the rigging in a moment of forgetful haste.

The hull of the " Ben Hebden " is solid except for a hollow under the pump-room housing, directly below the bridge, which contains a 4-6 volt battery-operated motor to drive the propeller, and a hollow under the poop-deck which contains lights for illuminating port-holes, engine-room skylights and the captain's cabin. Motor and lights were additions required for exhibition purposes. The hull was built up in layers cut to correspond roughly with the water-



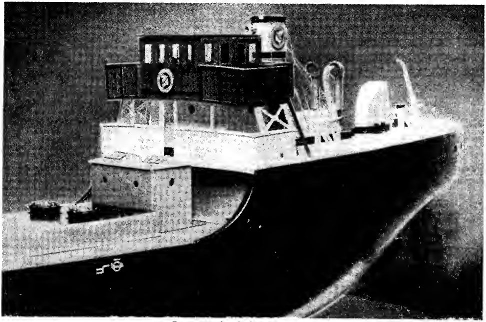
The bridge and main deck

line drawings used by the shipwrights, and was glued and compressed for forty-eight hours in a special cramp. Of chief importance at this stage is to have properly seasoned wood (yellow pine for easy working), straight grained and without knots. A thin, even coating of glue is sufficient and the cramp must be given a firm, even pressure over the whole length of the assembly to ensure that glue-lines are reduced to a minimum. If the layers are cut to the draught-lines before gluing, the shape then approximates to the finished hull and thereby saves much spoke-shaving in the final carving. Carving was done to a series of templates prepared from the same draught-line drawings as used for thicknessing and cutting the hull layers. Here it was found more accurate and convenient to make all the templates to half-hull shape taken at about fifteen intervals along the length of the hull. Carving was systematic, and was begun at the port bow and carried through on one side to the port stern, and the process repeated on the starboard, using, of course, the same set of templates for both sides.

Spoke-shaved to shape and rubbed down to an absolutely smooth finish with sandpaper, the final shape was treated with cellulose wood filler, prime-painted in gray, and finish spray-painted in two colours, black above and red below the water-line. On this model, the water-line is not straight but a gentle concave curve from stem to stern and to achieve an absolutely clean dividing line between red and black with no ragged edges required the most painstaking masking while operating the spray-gun.

Before final spraying, the portholes and hawse-holes were cut. Brass rings were turned to fit drilled holes in the hull for the portholes, and polished. Perspex discs about $\frac{1}{8}$ in. thick were pressed into the rings with a spot of glue for fixing. At this stage, too, the motor and propeller shaft were fitted temporarily and checked for correct working. The propeller shaft tunnel, being a hole some ten or twelve inches long, had to be drilled and burnt out by hand. The stern-post, cut from brass sheet, was located and fitted with a bush for the propeller shaft.

The finished hull, gleaming in red and black, with a knife-edge water-line and a pleasing shape looked very good indeed. It was mounted temporarily on four turned brass pillars on a makeshift baseboard for ease of handling, and deck-work construction was begun. The poop deck was first made separately in one unit, and made up from 1/64 in. by 3/32 in. stripwood to correspond with the deck planking drawings of the original, i.e. each plank was laid separately, glued to a cardboard template corresponding to the shape of the poop-deck *and* with the correct camber which had been carved to shape with the hull. This and the bridge-deck were the only planked decks required, the tank and forward decks being of iron.



Stern portion before completion

Bristol board was used to construct the deck-houses, captain's cabin on the poop deck, the pump room, engine room skylights, etc. (see photograph of bridge and main deck) but an essential feature of the bridge-deck was the teak construction employed by the shipbuilders. It was decided to build this up in the same manner as the actual ship, using small teak planks of an average 1/32 in. to 1/64 in. thick for the wheel-house and roof. This proved strong in practice and attractive in appearance although

the thinness of the teak planks gave trouble when the internal wheel-house lamp was fitted and light shone through the walls. This was, however, overcome by using a slim medical bulb fixed to the roof inside a slightly opaque Perspex cover.

While the construction work was going on, fittings were made ready for fixing in position as required. The wheel-house was completed internally with chart-table and flag-locker, wheel and helmsman's platform, compass binnacle, engine telegraph, helm position indicator, and all windows were fitted with Perspex, clear and polished to make this very small interior (not more than a $2\frac{1}{2}$ in. cube) as visible as possible.

Meanwhile the artist among C. A. Mills & Associates painted the insignia of the tanker operating company. These were metal discs $\frac{5}{8}$ in. diameter in yellow and black with the head of Mercury as centre-piece ; one on each side of the yellow, white and black funnel and one in the centre of the wheel-house, forward. All other fittings, bollards, fairleads, davits, ventilators, Typhoon pattern hooter, masts, were made as construction proceeded.

Amidships, the feature of the tank deck is the tank trunking which was carved separately and added after the final painting, being shaped to the rise and fall of the deck fore and aft. The inspection covers were made up in cardboard with dummy screw clamps and central relief valves. The working colour scheme of the tanker fleet was again followed, the top of the trunking black with buff sides, red decks and buff for the pump-room and bulkheads. Another photograph shows how the stern of the "Ben Hebden" looked when a major portion of the construction work was done, but before fitting stanchions, ships-boats, masts and rigging, wheel-valves and pipelines on the tank deck and so on. These were all fittings which could with safety be left until everything else had been checked against the drawings, and the motor and lights wiring checked for correct operation. The pump-room and skylights in one unit with Perspex lights was made detachable so that the motor could be serviced, and the after bulkhead was also made detachable to enable porthole illumination lamps to be changed.

Name and port of orgin were hand-painted to correct scale size as almost the last operation because these details were not decided by the owners until the model was nearly completed. This was therefore a tricky operation but was successfully carried out on the nearly finished model which obviously could not be handled in the easiest way for lettering.

Other points of interest in this fine model, are the strength and durability and the "look right" of the construction supporting the bridge-deck and wheel-house ; the use of sea-going colour scheme throughout the hull, deck-works, fittings and machinery, all of which were spray-painted or, if the specification called for it, left in natural or polished finish as for example the polished copper hooter and brass wheel-house fittings.

Incidentally, it is known now, that one of the deciding factors put forward by the prize-awarding judges, was the manner in which the correct colour scheme of the whole ship had been faithfully carried out. The model looked as if it was in sea-going trim.

A SIMPLE DARK-ROOM LAMP

A DARK-ROOM lamp suitable for use with bromide paper can be made from those brown-coloured jars usually sold containing cod-liver oil and malt. All that is necessary is to cut a hole in the screwed metal large enough to accommodate a lampholder, fixing it by means of its shade ring. A length of flex and an adapter can be added. An easy way of cutting the hole in the metal cap is to use a tank cutter or an ordinary wood centre bit. In

using the latter, the metal cap should be rested on a piece of wood and the bit revolved backwards, cutting the circle with the spur of the bit.

A 15-watt lamp is a suitable one for this simple device.

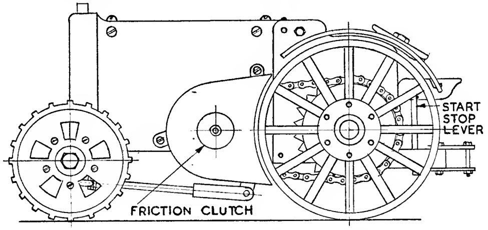
It is well to test the lamp with a strip of bromide paper placed about 2 ft. away. If on development there is no deposit after ten minutes, it can be considered safe. The photograph shows the lamp as described. — P. GRANGER.

A SIMPLE MODEL TRACTOR

by S. D. Stone

MY brother-in-law is one of those fellows who are never happier than when trying to make something which will work, out of something which won't work. Naturally, when his wife produced an old gramophone motor from some remote corner and presented it to him, he and his pipe retired immediately

The rear axle is carried on three ball races, the off-side rear wheel always running "free," and the "idler" sprocket, which is bolted to the inside flange of the near-side rear wheel, has eighteen teeth. Driving chain pitch is $\frac{5}{16}$ in. $\times$ $\frac{1}{8}$ in., and the number of teeth on driving sprocket is 16.



to the tool-shed-cum-workshop, and set to work on it. It is my firm opinion that my sister harboured an ulterior motive in producing this motor—you know what women are! Anyway, every evening, after a long day of putting damaged spitfires back into the air, brother-in-law put in an hour or two on the motor, repaired it, and decided to build it into a model tractor. Everything was made by hand, for his equipment is far from extensive, comprising only a small assortment of the usual fitter's hand tools.

The model is built along the lines of the conventional chain-driven tractor, having the motor disposed on its side, with the starting handle inserted at the front. The turn-table spindle has been removed, and the drive is taken from the original driving spindle, which has been extended to project about 1 in. out of the near side of the tractor; this spindle carries the driving sprocket, fitted with a simple friction clutch.

Additional thin steel plates and cross pieces are bolted around the motor, the radiator and rear plates being, in turn, bolted to them. The rear plates carry the back axle assembly, steering column assembly, driver's seat and the towing assembly. A stop-and-start lever, connected to the normal gramophone motor stop, is pivoted on the towing bar. Elongated bolt-holes are provided in the rear plates, to allow for adjustment of the driving chain.

The steering assembly, except for one or two minor differences, is constructed identically to that of a normal automobile assembly. The model is not sprung at all, but the front axle is pivoted under the radiator. Originally, the front wheels were bought for another job; they were entirely of rubber, but proved unsatisfactory as tractor wheels, being too weak and narrow, this was remedied by fitting them with steel discs at each side, and the whole assembly complete with ball race, bolted together into one unit.

A two-wheeled trailer of conventional design was constructed, having rubber tyred wheels mounted in ball-races, and generally of very solid design, weighing approximately $2\frac{1}{2}$ lb.

The weight of the tractor is approximately $9\frac{1}{4}$ lb. Length, 10 in. Diameter of rear wheels, $6\frac{1}{2}$ in.; front wheels, 3 in.

On fairly rough ground the tractor has towed a dead weight of about 32 lb., which, plus its own weight and that of the trailer, makes a total of 44 lb.; no mean performance. Operating on the floor of the drawing room, it has successfully towed a small tricycle, upon which my nephew, weight about 35 lb., was seated. With improved gearing, and improved tyres on the rear wheels, much better results are hoped for.

In fact, if you've any ploughing to be done and you're short of a tractor—well—!

INTERNAL SPHERICAL TURNING

by William Cleghorn

THE little tool-holder here described is by no means original, and no such claim is either made or intended, its principle has been used many times for milling objects which were not completely circular, such as eye and fork-ends for valve-gears, coupling-rod ends, etc., etc.

pivot could be introduced right inside the work and whose head or turret could then be turned easily yet not too easily. The ideal, would obviously be a worm-drive to the turret, but this would again take up extra room and so could only be used on large work; the next best would be some form of capstan-head which could be made a

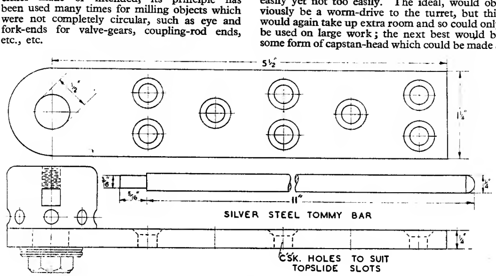


Fig. 1. The holder complete

The writer, having occasion recently to turn a large quantity of wooden bases with a radiused design, had a considerable amount of trouble due to ordinary wood-turning tools digging in, to the consequent detriment of the work and the tools. This propensity for digging in appears to be more pronounced when turning internally and is caused, probably, by one not having the same amount of control over the tool as when turning externally.

In an attempt to obviate this trouble, a globe-turning slide-rest was next brought into use; now a slide-rest of this type is very useful for turning balanced ball-handles and such-like external spheres, but when used for internal spheres it has an annoying habit of getting in its own way, as it were, especially so when the centre of the sphere being turned comes inside the work. This experience proved that a tool-holder was required whose centre or

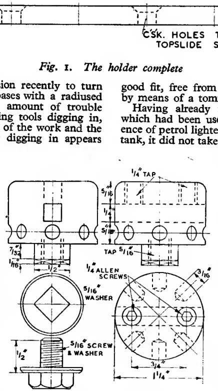


Fig. 2. Turret head

good fit, free from shake, and could be turned by means of a tommy-bar.

Having already made a similar type of jig which had been used for milling the circumference of petrol lighters which had a partly circular tank, it did not take long to drill and tap a couple of $\frac{5}{16}$-in. holes in this to hold a cutter and try it out on some scrap wood. This makeshift arrangement worked so well that a more compact design was thought out and constructed immediately; this is the design as illustrated in the sketches appended. It is astonishingly easy to set, and turns out lovely spherical internal surfaces with uncanny accuracy.

Application

It could, with care, be used on metals, but its use on woods is likely to be more general, especially for pattern-making, as so many of our readers are now making their own aluminium castings for

petrol engines and model aircraft. Another suggested use, when one takes into account the prevailing sky - high prices of wooden turnery of all descriptions, is for making one's own Christmas gifts, such as wooden bowls (for fruit and nuts), electric table-lamp stands, etc., a few examples being given in sketches 3, 4 and 5.

With regard to the dimensions of details, these can, of course, be varied to suit individual requirements (or the contents of one's scrap-box). A ½-in. square tool steel cutter would be ample for a small lathe, with two ¼-in. Allen grub-screws for holding the cutter, 3/16-in. tommy-bar holes, and a tommy-bar made from a 12-in. length of ¼-in. round silver-steel, with the end reduced to 3/16 in. to fit the holes.

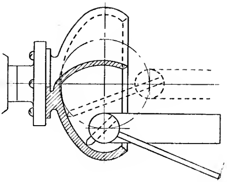


Fig. 3. False elliptical curve from two centres

Construction

The hardest part of the job is the filing of the square hole for the cutter; this could, if so desired, be left round, and a round tool-steel cutter used for the sake of simplicity. The supporting bar can be from ¼ in. to ⅜ in. in thickness by from 1¼ in. to 1½ in. wide, or it may have to be modified for use on a lathe not possessing a slotted top-slide. In the writer's case, the supporting bar is fastened down to the top-slide by means of ¼-in. countersunk screws; ¼-in. cheese-head Allen screws would be equally suitable as long as it is remembered that they must be sunk below the surface, so as to offer no impediment to the tommy-bar as it is moved around; for the same reason, it is desirable to remove all sharp corners and edges from the bar, to avoid fouling and also damage to the fingers.

The shank of the tool-turret terminates in a short square, which has a squared washer fitted to it, this prevents any tendency for the adjustment to slacken itself off while it is being rotated. The adjustment may be regulated to any desired degree of stiffness, or even locked positively by tightening the 5/16-in. set-screw below; when locked, the tool-holder may be used as an ordinary tool-holder. This gives the additional advantage of being able to use up one's worn-out tool-bits, which have become too short for the usual slide-rest tool-post. The sketches are, it is hoped, self-explanatory, sketches 3 and 4 showing objects which would be extremely difficult to make with ordinary hand-turning tools; the outside surfaces being fairly easy, the inside quite the reverse.

It is possible, with this tool-holder, to turn internally almost a complete sphere, at any rate three-quarters of the circumference of the sphere, sufficient space having, of course, to be left for the introduction of the tool. The only problem, when turning like this has to be done, is the removal of the chips; a jet of compressed-air directed inside will be found very effective in keeping the inside clear.

When setting the tool to cut a specified radius, all that is required is to allow the tool to project from the holder a distance equal to the required radius, minus half the diameter of the tool-post; in this case, ⅝ in.

A firm grip on the tommy-bar (or "podger," as we call it up in the north), which should be a nice, push fit in the holes, and a slow feed by pushing the tommy-bar, regulating the feed to suit the size of the cut, and no difficulty should be experienced.

Whilst wood-turning is hardly the province of the model engineer, nevertheless, the little tool described will be found a useful addition to the model engineer's workshop for those odd out-of-the-way jobs which one has to undertake at times. It will be found very easy to make with the minimum of equipment.

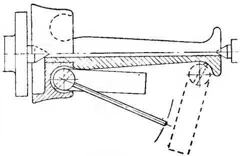


Fig. 4. Lamp stand with recessed base

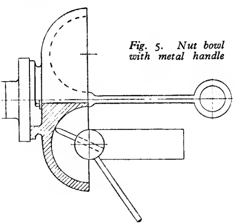


Fig. 5. Nut bowl with metal handle

"L.B.S.C."

THE BOILER FOR "JULIET"

ALTHOUGH the boiler for the little four-wheeler isn't such an elaborate box of tricks as that for the "Lassie," and only a fraction of the size, it will prove just as efficient in steam production. My three-cylinder compound "Jeanie Deans" has a boiler with a barrel which is exactly similar, and contains the same number of tubes arranged in exactly the same way; the only difference in the firebox is, that it is a little deeper, as there are no eccentrics or other impedimenta under it. This boiler provides all the steam needed, with a blast about as strong as the cough of an asthmatic black-beetle—the initial pressure in the L.P. cylinder seldom exceeds 15 lb. per sq. in., so you don't need telling what the exhaust pressure is!—and it doesn't need a Sherlock Holmes to deduce that the lively exhaust from "Juliet's" cylinders when those little wheels are spinning merrily, will keep the home fires burning, and the gauge needle well up to blowing-off point. My L.B. & S.C.R. engine "Grosvenor," which is now well on the way, is being furnished with a similar boiler, the difference in this case being merely that the grate slopes from back to front, as on big sister; and I am anticipating plenty of white feathers showing above the spring-balance safety valves on top of the dome.

To save unnecessary queries, if anybody wants to use a bigger boiler with a wide firebox (some folk prefer the "Bill Massive" variety) or to fit an oil-fired water-tube boiler, I will be only too pleased to give the necessary variations, as it is my earnest desire to please as many as possible. Builders preferring the last-named, need not wait for a separate drawing to appear, but can get busy making up a shell as described below for the loco-type boiler, using 18 gauge steel, and either riveting or brazing-up the throatplate as desired.

Barrel and Wrapper

In view of the continued shortage of copper tube—one of our advertisers told me he has just received delivery of boiler tubes ordered from a firm specialising in copper tubes, in January, 1946!—I have included a sketch showing a complete barrel and wrapper in the flat. To make this you will need a piece of 16-gauge sheet-copper measuring $11\frac{3}{8}$ in. by $12\frac{1}{4}$ in. At $4\frac{3}{4}$ in. from one of the shorter ends, each side, make a snip $2\frac{1}{8}$ in. long; then from there to the end, take off a $\frac{1}{16}$-in. strip each side. Now bend the whole issue into a circle $3\frac{1}{2}$ in. outside diameter; this allows a $\frac{1}{4}$-in. overlap on the barrel part.

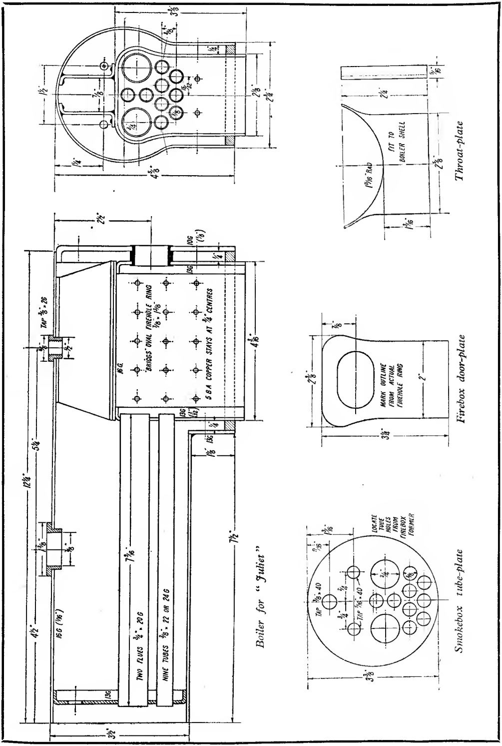
Young Curly used to bend boiler barrels around stone ginger-beer bottles (he respected his mother's rolling-pin), bits of rainwater pipe, or anything else that happened to be somewhere near right size. Tip to beginners: soften the copper sheet before attempting to bend it. Put a few 3/32-in. copper rivets through the overlap; then open out the $4\frac{3}{4}$-in. portion each side, to the shape of the firebox, as shown in the cross-section of the boiler. I made "Grosvenor's" boiler shell in an exactly similar manner, and it came out O.K. Provided that you use something as near the proper internal diameter ($3\frac{3}{8}$ in. as possible, you shouldn't have any difficulty in getting the barrel nicely rounded.

If a piece of $3\frac{1}{2}$-in. by 16-gauge seamless copper tube is available, it can be used. Square off the ends to a length of $7\frac{1}{2}$ in.; then bend up the wrapper from a piece of 16-gauge sheet copper, $11\frac{3}{8}$ in. long by $4\frac{3}{4}$ in. wide. Attach it to the barrel by a $\frac{1}{2}$-in. butt-strip extending three-quarters around the barrel, the job being carried out as described for the joint between barrel and wrapper on the "Lassie." Look that up, and you'll be saving me a lot of unnecessary repetition. Some folk will doubtless say, why not use a piece of $3\frac{1}{2}$ in. diameter tube squared off to a length of $12\frac{1}{4}$ in., and split and open out $4\frac{3}{4}$ in. of it to form the firebox wrapper? Well, you can if you like; but you'll find that the wrapper will be $\frac{1}{4}$ in. shallower at the bottom, consequently giving either less depth of firebox, or if the firebox is made to given dimensions, the foundation ring will be higher up, leaving $\frac{1}{2}$ in. of the bottom exposed instead of $\frac{1}{4}$ in., and sacrificing heating surface in the most valuable place.

Former and Throatplate

The backhead former will be needed for flanging the throatplate, so cut this out of $\frac{1}{4}$-in. steel or iron plate, to dimensions shown in the illustration. This isn't such a formidable job as it sounds; use a drop of cutting-oil on the saw, which should have 18 or 22 teeth per inch, bear down hard on the forward stroke, operating at about 60 per minute, and you'll find the blade will just walk easily through the plate. Finish with a file, and round off one edge.

Cut the throatplate from 3/32-in. or 13-gauge copper, to the shape shown in the illustration, but allow $\frac{1}{4}$ in. extra each side for flanging. The radius at the top can be made either by drilling a series of holes, breaking out the piece and filing to outline, or sawing it with a metal-piercing saw. I do mine on the "Driver" jig-saw, which takes only a few minutes—time is precious now! A spot of cutting-oil or a smear of beeswax helps the saw to cut easily and clean. Grip the plate and the former together in the bench vice, the plate being level with the bottom of the former, and beat down the edges to form flanges, as described for "Lassie," "Petrolea" and other engines. Anneal the copper at once, if it shows any sign of going hard, and starts to buckle; but such short flanges usually give no trouble of that sort. Clean up the flanges with a coarse-cut file; also clean the edges of the firebox wrapper where they will come in contact with the throatplate flanges, and the adjacent edge of the barrel.



Boiler for "Juliet"

Throat-plate

Firebox door-plate

Smokebox tube-plate

Insert the throat plate in position, with the metal immediately below the radius, butting up tightly against the edge of the barrel; hold temporarily in place with a toolmakers' cramp at each bottom corner, then put about three 3/32-in. copper rivets each side, to hold the wrapper in close contact with the flanges whilst brazing in the throatplate.

"The Tools for the Job"

As it is not so long since I described how to braze in the throatplate on the "Lassie's" boiler, there is no need to set out the complete ritual again; beginners and inexperienced workers who need full instructions, can refer to those notes, which also specified "the tools for the job." Briefly, stand the boiler, barrel upwards, in the brazing-pan, piling coke all around to the level of the throatplate, and putting some inside the shell. Anoint the joints with some flux mixed to a paste with water (Boron compo is as good as anything, for use with ordinary brazing strip) and after heating up all the whole lot as a preliminary, concentrate on one bottom corner of the throat-plate, applying the strip of brazing metal when the copper reaches bright-red. Then move the flame very slowly along, feeding in more brazing strip as the copper heats up to bright-red; and work your way up to the barrel, then around the joint between barrel and throatplate, letting the brazing metal melt and form a fillet from one side of the throatplate to the other. Then go either up or down the other side, as you fancy. Take care to run in plenty of brazing metal at the end of each "crack," where the wrapper merges into the circular shape.

If the barrel and wrapper are separate, made from tube and sheet, with a butt-strip inside, beginners and inexperienced workers are advised to run in a little coarse-grade silver-solder before applying the brazing-strip. The reason is, that this material "sweats" in easier than the strip, and is more likely to make a perfect joint. A good wheeze, and one which is essential if the joint is made with "Sifbronze," using an oxy-acetylene blowpipe, is to file a V right around, and fill it up with the brazing material. The boiler should be laid first on one side, then stood right way up, then laid on the other side, to go right around the joint in the proper manner. Beginners again note; never mind if you get a little too much brazing material on the job; it can always be filed off. Better be on the safe side than risk a crop of Welsh vegetables! Let the job cool to black before putting it in the acid pickle, then wash off in running water, and clean up with a handful of steel-wool.

Firebox

The firebox former, which also serves as a tube-drilling jig, is cut from 1/4-in. plate as before. Set out the location of all the tube holes as shown, and drill a No. 40 hole at each point. Lay the former on a piece of 13-gauge sheet copper, and scribe a line all around, 1/4 in. from edge, except at bottom. Repeat operation for firebox door plate. Cut out the pieces, and flange them over the former as previously described. Before removing the first one from the former, run the No. 40 drill through all the holes, going right through the copper. After removing from former, and filing up the ragged edges, run a 23/64-in. drill through all the holes for small tubes, and 47/64-in. for the flues, following up with 3/8-in. and 3/4-in. parallel reamers, respectively. Countersink the holes slightly on the side opposite flange. The door-plate is, of course, not drilled; merely file off the ragged edges. Clean up all the flanges with a coarse-cut file.

The firehole ring is made the same way as "Lassie's," from a piece of 1 3/8-in. by 1/8-in. copper tube squared off to 5/8-in. length. Turn down 3/16 in. of each end to a bare 1 1/4in. diameter, leaving 1/4 in. full diameter in the middle; anneal, and squeeze oval in bench vice so that the hole is approximately 7/8 in. by 1 3/8 in. Lay the oval ring on the firebox doorplate with the centre 7/8 in. from the top; scribe a line all around it, cut out the piece, clean ring and plate, poke the lip of the ring through the hole, from the side opposite flange, and beat it outward and down until tight.

A piece of 16-gauge sheet copper 9 in. by 4 3/16 in. is needed for the sides and crown of the firebox. This is annealed and bent to the shape shown in the cross-section of boiler, using the end-plates as guides. The flanges of the end-plates are cleaned up with a coarse file, also the edges of the firebox side and crown, and the ends are then riveted in with a few 3/32-in. copper rivets. Only enough are needed to hold the parts together whilst brazing; they take no part at all in helping the boiler to resist pressure, the brazing taking care of that part of the business.

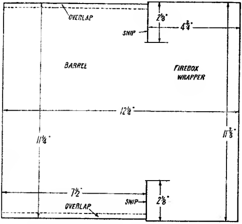
Girder Crown-Stays

The two girder crown-stays are made from 16-gauge copper, 4 3/16 in. long at bottom, 3 1/4 in. at top, the upper flanges being 1/4 in. wide, and the lower 3/8 in. wide. They are riveted to the crown of the firebox at 7/16 in. each side of the centre-line, half-a-dozen rivets in each being plenty. In these days of shortage, I use all sorts of scrap sheet for things like girder flanges; used and discarded photograph printing blocks, for example. Those I used were 16-gauge copper of excellent quality. The firebox and crown-stay assembly can then be brazed up, using the same "technique" as for the throatplate. When you come to the crown-stay girders, stand the firebox right way up, and run a good hefty fillet of brazing material along the inner side of each girder, opposite to the flange. Certain "die-hards" are still moaning about the liability of these girders to tear away from the firebox crown; all I can say is, that if one did, the firebox crown would come with it! How do I know—why, bless your hearts and souls, I've tested one to complete destruction. It isn't any game of Curly's to dole out a lot of untried ideas, or "paper designs," and leave unfortunate builders to find out if they are O.K. or otherwise, maybe at some risk to themselves. I *build* locomotives, and put them on the track instead of on paper only; readers of these notes get the benefit of my experience.

Smokebox Tubeplate and Tubes

The former for the smokebox tubeplate can be anything circular and of the right diameter; I

use old wheels, chuck-plate castings or anything else that may be handy. The required diameter for "Juliet's" boiler is $3\frac{1}{4}$ in., and one edge should be rounded off, same as in the case of the shaped formers. Cut out a circle of 3/32-in. sheet copper $3\frac{7}{8}$ in. diameter, anneal it, and flange it over the former as previously described. Chuck in the three-jaw, flange outwards, and skim off any raggedness; then reverse and re-chuck on the outside of the top step of the outside jaws, gripping by the inside of the flange. Turn down

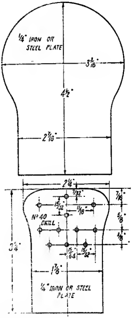


Barrel and wrapper "in the flat"

the flange until the tubeplate is a tight fit in the boiler barrel. In passing, several correspondents who are building the "Lassie" complained that I gave the wrong size for the formers, saying that they should have been the size of barrel, wrapper, etc., inside, less two thicknesses of the metal. Not at all; I gave dimensions for the formers, that ensured plates fitting correctly. For example, according to these correspondents, the diameter of the former for "Juliet's" smokebox tubeplate, should have been $3\frac{3}{16}$ in., allowing for two thicknesses of metal, which would have brought the diameter of the plate nominally to $3\frac{3}{8}$ in., the internal diameter of the boiler barrel. Sounds all right, but ignoring the fact that the metal becomes thinner when hammered down to form the flange, there wouldn't have been anything left to take off by turning! The finished diameter of a 3/32-in. plate flanged over a $3\frac{1}{4}$-in. former, is approximately 3 13/32 in., which allows for taking a skim off the flange in order that it may fit the end of the barrel in the proper manner.

The setting-out, drilling and tapping of the steam-pipe and stay-holes in the smokebox tubeplate, are shown in the accompanying illustration. To locate the tube-holes, simply clamp the firebox former to the tubeplate with one or two toolmakers' cramps, the centre of the middle hole in the bottom row being approximately $\frac{3}{8}$ in. above the flange. Put the drill through the lot, then open out and ream exactly as you did those on the firebox tubeplate.

Two pieces of $\frac{3}{4}$-in. by 20-gauge seamless copper tube, and nine pieces of $\frac{3}{8}$-in. by 22- or 24-gauge ditto, are the next requirements; cut them full length, and skim off the ends in the lathe until the overall length is $7\frac{9}{16}$ in. Clean the ends with rough emery-cloth, clean the tube holes in the firebox tubeplate, and insert the tubes, letting them project a bare $\frac{1}{16}$ in. into the firebox, and putting the smokebox tubeplate on the other end, to act as a steady and a spacer. Line up the whole nest parallel to firebox sides, and square with the tubeplate; they can then be silver-soldered in, exactly as described for the "Lassie." Experienced coppersmiths can do the lot at one fell swoop; beginners are advised to insert the two flues and the two small tubes between them

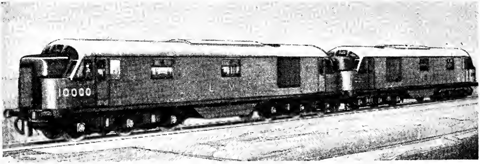


Formers for throat-plate, backhead and firebox

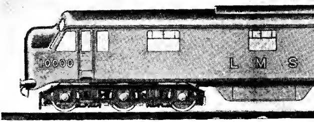
first, and silver-solder them. The rest can then be inserted and silver-soldered as a separate operation. If 24-gauge tubes are used, don't use an oxy-acetylene blowpipe to do the silver-soldering, as tubes of this thin gauge, whilst quite able to stand the working pressure (thinner tubes on Sir Hiram Maxim's first steam aeroplane, built when I was a kiddy, stood 500 lb. per sq. in. easily) are very easily burnt. As one of the old comic songs says, "It's done before you know where you are!" Personally, I prefer the big diffused flame of an oxy-coal-gas blowpipe, or a paraffin blowlamp, for silver-soldering boiler tubes. Anyway, whether you put them in at one shot, or by two bites, take off the smokebox tubeplate and heat the outer ends to dull red, before putting the job in the pickle. I guess that will be enough to keep builders busy for a week or so, so we'll leave the assembly till the next instalment.

L.M.S.R. 100 M.P.H. DIESEL-ELE

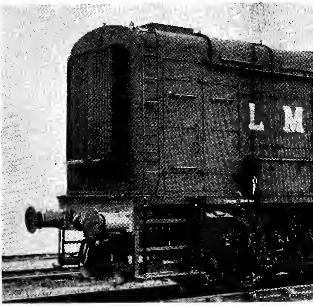
Important Main-line Experiments to be Made in Conjunction



An artist's impression of the L.M.S. new design 100 m.p.h., 3,200 h.p. diesel-electric locomotive which the L.M.S. is to introduce experimentally on its main lines



An artist's impression of the L.M.S. new design 1



Existing standard L.M.S. 350 h.p. diesel-ele

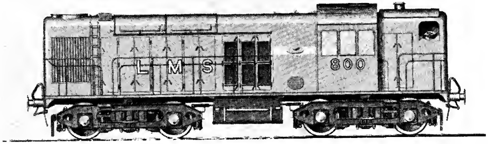
THE L.M.S. Railway has decided to introduce diesel-electric traction to its main-line services. Diesel-electric locomotives are being built for experimental use in main-line passenger and freight services, including the most important express passenger trains on Anglo-Scottish services. This is the first time that experiments on these lines have been conducted in Great Britain, and they may ultimately prove of great importance to British railway traction progress.

The first experimental design is for express passenger services. The diesel-electric locomotive will be of 3,200 h.p. (composed of two 1,600 h.p. units coupled together), and will be capable of hauling the heaviest trains between London and Glasgow, or alternative fast light trains between these cities. The new type of locomotive will be able to work services comparable with the pre-war "Coronation Scot" train, which was normally worked by the Company's most powerful 4-6-2 steam locomotive.

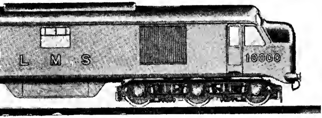
The new locomotive will be in two units, and the English Electric Company are providing 16-cylinder diesel engines of 1,600 h.p., and electrical equipment, for each unit. The diesel engine will be to the firm's own design, based on the engine used in the L.M.S. diesel-electric shunting locomotive. The L.M.S. is building the mechanical parts of both units in its Derby workshops. The locomotive will weigh 220 tons, and it will be capable of speeds of 100 m.p.h. A flexible gangway is being provided between the units, so that the length of the locomotive can be traversed for inspection purposes while running. The first locomotive of this type will be put into service between Euston and Glasgow, in competition with the modern 4-6-2 type steam locomotive at present in use.

EL-ELECTRIC LOCOMOTIVES

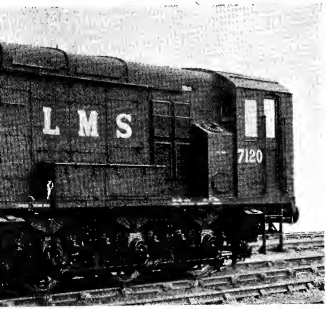
e in Conjunction with Outstanding Coal-saving Developments



An artist's impression of the L.M.S. new design 800 *h.p. diesel-electric locomotive which the L.M.S. is to introduce experimentally for branch and cross-country passenger and freight services*



e L.M.S. new design 1,600 *h.p. diesel-electric locomotive*



I.S. 350 *h.p. diesel-electric shunting locomotive*

The second experiment of diesel-electric locomotives is the use for separate work of each of the two units which make up the express passenger locomotive. These 1,600 h.p. locomotives will be used for suburban and semi-fast passenger trains and medium-weight main-line freight services such as are now hauled by large 2-6-4 tank steam locomotives. Examples of the work which the new locomotive will undertake are the outer London suburban passenger services to Bletchley and Luton, passenger and freight working on the North Stafford section round Stoke and in the Derby, Nottingham and Leicester areas.

The third experiment is an 800 h.p. diesel-electric locomotive suitable for branch and cross-country passenger and freight services, of comparable capacity with the Company's small 2-6-2 tank steam locomotives. The 16-cylinder diesel engine, generator, traction motors and control gear will be provided by the British Thomson-Houston Company. The engine will be built by Davey Paxman as sub-contractors to B.T.-H. and will be of a design developed by Davey Paxman for the Admiralty during the war.

To obtain the highest possible use of the locomotive, it is being designed so as to be capable of secondary passenger and freight services and shunting, and since shunting requires vision fore and aft for the driver, it will be of the single-cab type with engine encased under a bonnet.

Such a locomotive should be capable of speeds of 60 m.p.h. with light passenger trains, and on completion it will be used on a variety of mixed services all over the country.

These main-line diesel-electric locomotives will result in a substantial saving of coal; for example, a main-line diesel-electric unit of 3,200 h.p. would,

(*Continued on next page*)

A Miniature "Elizabeth Jonas"

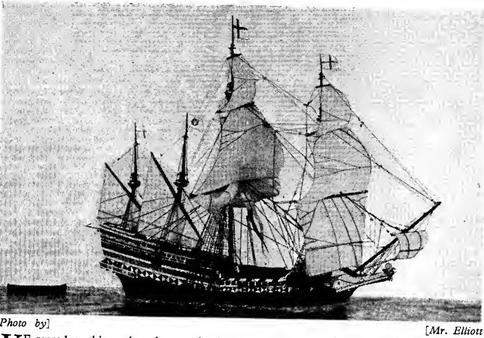


Photo by] [*Mr. Elliott*

WE reproduce this week a photograph of a very interesting example of the familiar *Elizabeth Jonas* model. It was made by Mr. Donald McNarry, of Barton-on-Sea, Hants., well known as an exhibitor at our annual exhibitions, from the plans published by the Science Museum. The scale is one-eighth the size of the original model, giving an overall length from bowsprit to bumpkin of only 7 in.

The hull and poop were made of solid sycamore, most of the deck fittings of Bristol board, the masts of sycamore, the sails of taffeta, the rigging of silk and cotton, and the flags of cigarette paper. The ship is mounted on a very effective sea, and is shown towing the long boat. A smaller boat is stowed on the main hatch. The whole effect is very realistic, especially considering the small scale of the model.

Waterline models of Elizabethan ships and galleons are not very common, which is rather surprising as they are usually shown in full sail. In this case the sea adds considerably to the realism of the model, the quiet ripple of the sea matching very naturally the moderate bow wave and the slight disturbance of the water alongside. Models, and more especially pictures of galleons, are usually associated with high winds and turbulent seas. In this instance we have a refreshing change from that kind of thing

L.M.S.R. Diesel-Electric Locomotives

(*Continued from previous page*)

on its annual mileage, save some 2,500 tons of coal per year.

These experiments represent the next step in the development of the diesel locomotive in this country, pioneered by the L.M.S. fifteen years ago. After four years' trial with various types of diesel shunting locomotives a design was evolved in 1936 which became the standard and which was to prove invaluable during the war not only for use in this country, but also abroad. This standard shunting type is a 350 h.p. diesel-electric unit, the diesel engine and electric transmission being manufactured by the English Electric Company. The L.M.S. now has forty of these locomotives in service (though a further forty-two were built during the war for the use of the British Armies in Africa and the Near East), and ten are under construction. The building of a further hundred was deferred during the war. The consumption of oil per locomotive per annum is fifty tons against a coal consumption of 600 tons per annum. *When those under construction are completed, the aggregate reduction in coal consumption will be 30,000 tons per annum.*

The data which have been obtained of the performance of these locomotives show clearly that they have proved strikingly successful where continuous twentyfour-hour operation is required in important traffic yards, such as Toton, Willesden, Crewe, Carlisle and Liverpool (Speke).

PETROL ENGINE TOPICS

* A 15-c.c. FOUR-CYLINDER ENGINE

By Edgar T. Westbury

WE come now to a part of the construction which involves quite a few knotty problems in layout and execution; namely, the camshaft and timing gear. Many prospective constructors of multi-cylinder engines have been deterred by the apparently formidable task of making and setting the cams; while others, starting out lightheartedly, but with no very definite idea of procedure, have met their Waterloo when this stage of construction was reached.

In a published design for a multi-cylinder engine, which I once examined, the camshaft details supplied were very vague, and the instructions "File cams as required" struck me as being delightfully optimistic! While it is no doubt possible to make a camshaft in this way, the chances of it being accurate, either in respect of cam contours or their timing, are very remote; and it is equally unlikely that an engine fitted with such a camshaft would develop the best possible efficiency. Much of the success of multi-cylinder engines depends upon obtaining equal efficiency from all the cylinders, and the importance of uniformity of valve lift and timing is beyond all question.

However, like many problems in life, the engine can testify. The present engine has twice as many cams, and they are smaller in dimensions, but the same methods are applicable, and I propose to adapt them, with suitable modification of detail, to the job now in hand.

It may be remarked that in the making of a camshaft, one has the choice of making the cams separately, and mounting them on the shaft, or machining the cams in position as an integral part of the shaft; just as, in steam-engine construction, cranks and eccentrics may be built up or machined in one piece. To many constructors, it may appear that the former method is the simpler, and this is quite correct in certain cases. It would, for instance, very much simplify the production of the cams, and ensure their complete uniformity of shape, if all of one kind were clamped together in a bank, and formed at once. The four inlet cams and the four exhaust cams could thus be dealt with in two operations. Unfortunately, however, with cams made in this way, further problems arise, not only in the secure attachment of the cams to the shaft, but even more so in ensuring their correct relative position to other cams. I do not know of any really simple way of setting separate cams of the size now under consideration, in such a way as to

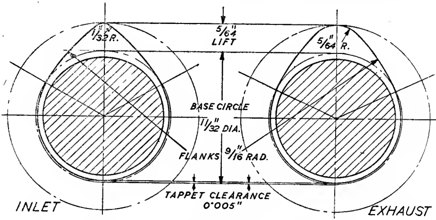


Fig. 20. Contours of inlet and exhaust cams (four times full size)

anticipation may be worse than the real thing, and it is possible, by adopting commonsense methods, to make the production of an accurate camshaft not only a fairly straightforward, but also an interesting exercise in machining. In the construction of the twin engine for "1831," problems of a similar nature were encountered, but the methods evolved for dealing with them proved to be highly effective, as many constructors of the

*Continued from page 491, "M.E.," April 17, 1947.

be quite sure of their correct angular location within a limit of one degree of camshaft angle, which represents two degrees of crankshaft angle.

For this reason, I strongly recommend the use of a solid camshaft with all the cams formed on it. This calls for careful setting out, and it is obviously necessary to eliminate the possiblity of errors, as they cannot afterwards be corrected; but it enables the cams to be timed to a very close limit of accuracy, and there is no risk of individual cam timing ever becoming altered.

Camshaft Blank

Details of this will be given later, and its production is a fairly simple turning operation, which can be carried out between centres. The material recommended is a good case-hardening mild or low alloy steel, and if one is able to exercise any choice in the matter, try to select a make or grade that can be guaranteed to distort very little in quenching. Steels vary enormously in this respect, but if little is known about the steel used, normalising before machining is helpful.

Hardening of a long shaft is always bound to be fraught with some risk, and it would be very nice if we could dispense with it in the case of a component which calls for a good deal of previous machining, such as a camshaft, because it is a serious matter if the part is spoiled by distortion or hardening cracks. However, a soft cam is impracticable, as it would soon lose the accuracy of its profile, even if made of fairly hard-wearing material. The only possible alternative to hardening is the deposition of a hard chrome layer on the steel, which I have not tried out for this particular purpose.

It is practicable to straighten a distorted shaft, though this may be a rather tedious job. To facilitate it, and avoid cracking, the shaft between the cams should be left soft, but there may be some difficulty about this in practice. In production, the usual method of obtaining soft zones in a hardened component is to leave these parts well oversize until after carburising, and then machine away the carburised surface, prior to reheating and quenching. There are other ways of producing local hard and soft zones in machined parts, but generally speaking, they are either more troublesome or less reliable—sometimes both.

All this may sound very complicated, but it will be found much better to consider all eventualities than to blunder in with haphazard methods and finish up, as likely as not, with a spoiled camshaft, after many hours of patient work.

To avoid the risk of hardening cracks developing, small but definite internal radii should be left in all corners of the camshaft. This may appear to be a very small matter, but a "fillet" or radius helps to distribute stress and to prevent the formation of a focal point from which a crack may start and spread. I know of many failures in highly-stressed parts, not only in models, but also in full-sized engines, which have been directly due to stress localisation in sharp corners. Hardened parts are particularly important in this respect, as the sudden change of state in quenching introduces surface stresses in the metal at the corners.

It is advisable, though not absolutely necessary, to defer the finishing of the journals at the ends of the shaft until after the cams are formed, but they should be turned to a definite size to facilitate their fitting to the cam forming jig, which will be described later.

Cam Contours

Before machining the set of cams, their contours should be fully determined and understood. It may be remarked that the contours selected for these particular cams are dictated more by convenience in production than the desire to obtain the utmost ounce of efficiency from the engine, though the latter consideration has not been entirely neglected. In other words, the shape is a compromise between that which gives best results, and that which is easiest to form accurately; and this is true of most cams used in automobile practice, other than those of specially-made racing engines.

The duty of the cams, at speeds within the range for which this engine is designed to work, is fairly easy, as the inertia of the moving parts of the valve-gear is kept as low as possible; in this respect, it may be noted that a side-valve engine is at a great advantage over one with overhead valves, especially when the latter is designed for high performance, involving maximum strength and rigidity of valves, rockers and push-rods. Direct operation of the valves through the light thimble tappets relieves the cams of a great deal of inertia load, and conduces to smooth, effortless working.

Fig. 20 shows the contours of the inlet and exhaust cams respectively. It will be seen that both are symmetrical and have convex flanks, the flank radius being the same in each case, but as the opening period, or angle from the base of one flank to that of the other, is greater in the case of the exhaust valve, the nose of the latter is correspondingly broader. For convenience in forming, all curves in the cam contours are built up of true circular arcs; and as the flank curves are all the same, the difference in opening period is allowed for by making the radius at the nose different in the two cases.

The relative positions of the inlet and exhaust cams are determined by reference to the timing diagram, which is shown in Fig. 21. In accordance with normal practice, this is set out in terms of crankshaft angle, and the opening and closing position of each valve is measured from the top and bottom dead-centres respectively. The timing is fairly normal for an engine of this type, with the exception of the fact that as r.p.m. will be higher than most full-sized engines, and lost motion in valve gear relatively great, the opening periods and "overlap" are slightly on the full side. This policy, it may be mentioned, has been suggested by experience in timing these small engines.

Having decided on the valve timing, it is now necessary to translate the timing diagram in terms of camshaft angle, which, of course, involves halving all the angles; it is also more convenient to work around the circle from 0 to 360 deg. instead of working from top and bottom centres of the crankpin or piston. A single stroke of the piston only represents 90 deg. of the camshaft diagram, and there will thus be two top dead centres and two bottom dead centres shown, but the diagram starts from the top centre of the firing stroke, which is the zero point in the diagram on the right of Fig. 21.

To further clarify this diagram, the cam contours are superimposed on it, so that the juxtaposition of the inlet and exhaust cams for any one cylinder of the engine, and their relation to their respective crank centre, may be clearly seen. It will thus be observed that as the cams rotate, the exhaust cam commences its lift at 60 deg. from zero point, reaches its full lift at

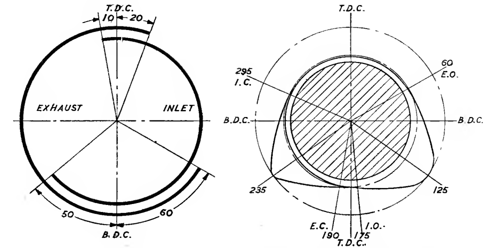


Fig. 21. Timing diagrams, in terms of crankshaft and camshaft angles respectively

125 deg., and completes its drop at 195 deg. Before the period of this cam is completed, the inlet cam has begun its lift at 175 deg.; it reaches full lift at 235 deg., and completes its drop at 295 deg., leaving 65 deg. to complete the full circle of rotation.

Arrangement of Eight Cams

This gives the positions of the cams for one cylinder only; it is now necessary to consider the relative positions of the cams for the other three cylinders. The firing order for this engine is 1-2-4-3, starting from the timing end, and as the camshaft is geared to the crankshaft with an idler in between, it will rotate in the same direction, which is anti-clockwise at the timing end. Thus the sets of cams for the four cylinders will come into operation in the order given, each set being 90 deg. behind the other in an anti-clockwise direction of rotation.

There are several pitfalls for the unwary in the setting-out of a set of cams, as I can testify, having made quite a few mistakes in my time! It is very easy to set the cams to give the wrong direction of rotation, or to put the inlets where the exhausts have to be. Correction of these mistakes is practically impossible, so it is advisable to think hard before acting. Note that the sets of cams do not follow in ordered sequence, as regards the endwise position of inlet and exhaust cams; there is first an exhaust cam, then two inlets, two exhausts, two more inlets and finally one more exhaust. These positions have not been selected just to make it more awkward for the constructor, but to simplify manifolding of inlet and exhaust pipes.

The sequence of the cams can be seen clearly by reference to Fig. 22, in which the letters A B C D E F G H refer to the cams in order of their endwise positions on the shaft, and the angular position of each cam is shown, in its relation to the top dead centre of No. 1 cylinder. Note that as No. 1 and 4 cylinders have their cranks in the same plane, but fire on alternate revolutions, their pairs of cams are in opposite phase. Nos. 2 and 3 cylinders similarly have their pairs of cams in opposite phase to each other, but displaced either 90 or 270 deg. to the corresponding cams of Nos. 1 and 4 cylinders.

As I have, on many occasions, reminded readers that it is one thing to design components on paper, and quite another to make them exactly as designed, I shall proceed in the next instalment of these articles to show how the cams may be produced with simple equipment.

Dead—but Won't Lie Down!

Several times in the past I have had to refer, almost in apologetic terms, to the ancient design of engine known as the "Kestrel," which was introduced to readers in 1937, and might therefore be expected to have earned retirement on a pension. But somehow, the engine—or its constructors—will not accept dismissal, and though "old and rough, and dirty and tough," like Barnacle Bill, it refuses to settle down to a decent and discreet senility. I mentioned some time ago that die-castings for this engine had been produced by Mr. L. D. Johnson, of Birmingham, and it is now brought to my notice that Mr. S. A.

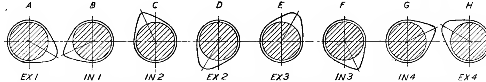
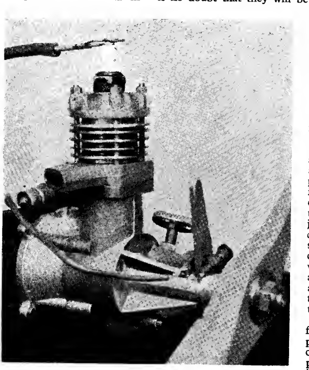


Fig. 22. Relative angular positions of cams, with No. 1 piston at top dead centre

Smith, of Chatham, is using these castings in the production of finished engines, one of which has been submitted to my inspection.

I find that the workmanship is very good indeed, and carried out faithfully to the original design, with the exception of one or two minor details, such as the use of a plain iron piston instead of an aluminium piston with two rings—a modification which is quite in order and in keeping with modern practice. The sample submitted started up readily and ran quite consistently, though being new, and a little on the stiff side, no attempt was made to force the pace or to obtain very high performance. Mr. Smith supplies this engine fitted either for aircraft or racing-car installation, and is prepared to undertake tuning for high efficiency. The appearance of the engine is good, largely due to the quality and accuracy of the die-castings, and those who are looking for a sound, reliable and well-designed engine, might do much worse than try this genuine antique design.



A 5 c.c. Kestrel engine, as produced by Mr. S. A. Smith from die castings supplied by Mr. L. D. Johnson

"Future Plans"

Many thanks to the numerous readers who have responded to my invitation to record their views on this matter. The letters received are all extremely interesting, though hardly any two of them express quite the same opinions, and it would appear that the "Ideal Petrol Engine" is as elusive as the "Ideal Lathe!" However, there is no doubt that they will be of great value in shaping policy in future articles and designs.

With regard to the judging of these entries, a somewhat difficult problem arises, in that a few of the letters are from my personal friends, and as I am most anxious to avoid any possible suspicion of favouritism, I have decided to submit the entries to the judgment of independent persons. The result of the competition will be announced as soon as possible and it is likely that in view of their general interest, it will be found desirable to publish several of the letters, in part or entirely, in THE MODEL ENGINEER.

(To be continued)

An Exhibition of Models in Sussex

The first annual exhibition of the Mid-Sussex Model Engineering Club was held recently, at the Public Hall, Haywards Heath. There were models of every description on view, including a model passenger-carrying railway, the track of which was recently constructed by some of the club members, and a film show.

Prizes for the best models exhibited were given as follows:

A silver challenge cup, to be held for one year, presented by Mr. K. Banks, for the best model made by a member of the club, was won by Mr. W. Warnett for a 2½-in. gauge "Fayette" type locomotive; Mr. F. Wilkins was awarded the second cup, given by Mr. Whittington, for a 2½-in. gauge "Dyak" locomotive, and a third prize of £1 voucher given by the club went to Mr. A. Funnell, for an 18-cylinder radial petrol engine. A silver cup, given by the club for the best model by any visitor, was awarded to Mr. E. L. Mead, of Brighton, and the second prize of £1 voucher went to Mr. D. Lockett, of Burgess Hill.

A 3½-in. gauge "Maisie" locomotive, kindly loaned by Mr. D. L. Venus, of Hassocks, did most of the work on the track, and Mr. Sulivan, of the Sutton Model Engineer Club, also loaned his 3½-in. gauge "Silver Queen" locomotive on the last day.

Another attraction was a cinema show with films kindly loaned by the Southern Railway. The exhibition was a great success, and the club takes this opportunity of thanking all who made it possible.

Hon. Secretary: A. L. PALING, 31, Broadway Buildings, Haywards Heath, Sussex.

*A Tandem Compound Engine

by "Crank Head"

WHILST on the subject of the governor, it should have been mentioned that wherever necessary, oil-holes have been provided, although they have in many cases been omitted from the sketches.

Fig. 17 is a sketch of the main valve for H.P. cylinder, and, as will be seen, is really in the main, an ordinary D-valve with the exception

the steam ports. Fig. 18 shows two views of the expansion-valve, which is just a plain valve sliding on the back of the main valve, and is controlled by the action of the governor through the medium of the expansion-valve rod. The chief point about this valve is that its overall length must be such that in mid-stroke it just covers the ports in the main valve; in other words, there is no lap

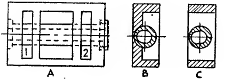


Fig. 17

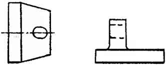


Fig. 18

Fig. 19

that it is sufficiently long to allow the steam ports 1 and 2 to be cut through it as shown at *A*, Fig. 17, allowing whatever lap may be required on the inner edges of the ports, the total width of the port being equal to the width of port in the valve-face on the cylinder. The foregoing remarks are only a generalisation; the actual details and dimensions need to be arrived at by geometrical methods.

As the ports are cut right through the valve, and the valve spindle also passes through the valve, but at right-angles to the ports, some means must be adopted to prevent steam passing from one port to the other *via* the valve-spindle passage. This was provided for by boring a hole larger in diameter than the valve-spindle, and forcing a brass bush with a collar at one end and a round nut at the other right through the valve; see *A*, Fig. 17. After the bush had been placed in position and the nut screwed up, the end of the bush was riveted over the nut, lightly, more to prevent the nut slacking back than to prevent the bush moving; this latter defect is not anticipated, as the bush was made a driving fit in the valve. It will be noted that the bore of the bush is not round, but elliptical, the major axis being at right-angles to the face of the valve; the reason for this departure from the round is to allow the pressure of the steam on the back of the valve, to keep the latter tight up to the cylinder valve-face when under working conditions.

B and *C*, Fig. 17, show sections of the valve through (*B*) the exhaust cavity, and (*C*) one of to the valve. The width can be equal to the total width of the main valve. It will be noted also that the hole through which the valve-spindle passes is elliptical for the same reason as that in the main valve. The ovalness of this hole also permits the slide-valve to be forced slightly off the valve face, in the event of a quantity of water being imprisoned in the cylinder such as might happen if the boiler should prime.

Fig. 19 shows the main valve-spindle and needs no description other than to remark on the flat which is filed on the tail end of the rod where it works in the dummy gland on the back end of H.P. valve-chest. This flat is to permit any condensed steam to escape from the dummy gland. The valves are both of cast-iron, and the ports in the main valve were drilled roughly to size, and finished by filing. The exhaust cavity was milled on the vertical slide in the lathe, as far as possible, then squared up by chipping and scraping.

Fig. 20, *A* and *B*, show two views of the valve-chest. For some reason which cannot now be remembered, no H.P. valve-chest was provided when the other castings were made, so one had to be fabricated; here is the method employed: Two pieces of flat bar steel of suitable dimensions were obtained from the local blacksmith (a very valuable friend); each piece was bent at right-angles; thanks to the smith, who let me use his fire, not the first nor the last time, either! The corners were squared up as far as possible, and the two pieces then fitted together to form a rectangular box; the joints were then cut at an angle as in sketch, clamped together, and submitted to the tender mercies of the acetylene

**Continued from page* 511, "*M.E.,*" *April* 24, 1947.

welder. The whole was then placed in the fire and annealed, and when cool was ready for fitting the bosses which were to be machined to form stuffing-boxes for main and expansion-valve spindles. The sketches will explain the method adopted; the blanks being fitted, were silver-soldered in position.

At this stage, the hole for the pad on which to secure the regulating-valve was drilled and tapped. All the work which required heat having now been done, the valve-chest was first filed up on the outside surfaces, and the edges planed up square and parallel in the hand-shaper. The holes for studs which secure the valve-chest to the cylinder-face were then marked off and drilled; this method of securing the valve-chest is certainly not in accordance with the best engineering practice, but in this instance could not be avoided, as the face on the cylinder was not large enough to accommodate the valve, and allow for a flanged joint to secure the valve-chest.

The valve-chest was now mounted on an angle-plate in the lathe, and the stuffing-box for the main valve-spindle machined; without removing the chest from the angle-plate, it was again set up true with the centre of the expansion-valve spindle, and the second stuffing-box bored and machined. The valve-chest was now removed from the angle-plate, and the hole for the dummy gland marked off in line with the bore for main valve-spindle. The job was then replaced in the lathe, and the hole bored and screw-cut.

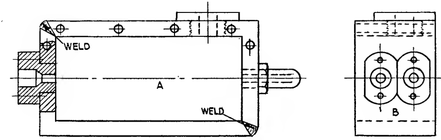
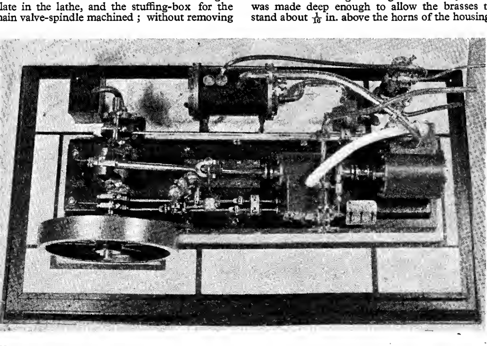
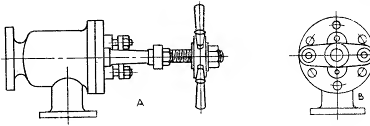


Fig. 20

The pad for regulating-valve was now made and screwed into its place in valve-chest and jointed with a mixture of red-lead and gold-size. The dummy gland for the valve-spindle tail-rod was now made and fitted; with the exception of making the glands, which was just a straight-forward job of turning and needs no description, the valve-chest was completed.

The guide for the valve-spindles was next made, and was built up in three pieces, the foot, which is a piece of small angle squared up on all faces, with the column shrunk into it, the top end of the column was, in turn, shrunk into the lower half of the housing holding the brasses, which was made deep enough to allow the brasses to stand about $\frac{1}{16}$ in. above the horns of the housing.





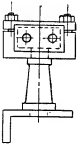


Fig. 21

Fig. 22

The keep was thus a flat piece of steel fitted snugly between the flanges of the brasses, and held in position by two ⅛-in. studs. Reference to Fig. 21 will explain the detail of this fitting. This method of construction also applies to the guide for L.P. valve-spindle.

Fig. 22 *A*, *B*, *C*, *D* and *E* show the regulating valve, and details, *A* being a side elevation of the complete valve ; *B* a front view of the valve with the capstan-wheel removed ; *C* the component parts of the valve body which is made of mild-steel, machined from the solid bar, and silver-soldered together ; *D* a section of the valve cover, and *E* the valve which is of bronze.

Having machined the external portions of the valve body, the outlet branch was machined to fit the hole which was bored in the main body of the valve, and then driven into position. The outlet was then silver - soldered in place, both from inside and out, the inner edge of hole in the main body having been slightly chamfered before assembly. This made a good sound job, and was given a good deal of care, as no troubles were wanted either during the machining or in service. When the assembly was completed the valve body was held in the chuck and the internal machining nearly completed, including the boring for the bronze valve-seating, which was now turned and roughly bored to size, and without taking the valve body out of the chuck was pulled into its place ; this was done by removing the chuck from the lathe, and passing a long ¼-in. bolt through the valve body from the back of the chuck, the end of the valve seating, which was turned just small enough to enter the bore in the valve body, was passed over the bolt, and a ferrule small enough to pass into the large part of the body, but too large to enter the bore of the valve-seating, was also passed over the bolt. A nut was now screwed on the bolt and the seating pulled into its position (see *C*, Fig. 22). The bolt was then removed, and the inside of the body, and valve seating machined to finished sizes ; the flange for cover was also machined at this time.

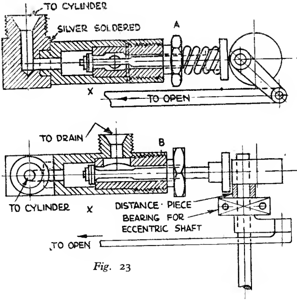


Fig. 23

The valve-body was then removed from the chuck, and placed on a suitable mandrel ; the flange for steam inlet, and

end of valve seating were then turned to a finish. The valve-body was then placed bottom upwards on an angle-plate and the flange on the outlet branch machined.

The cover was next made, the outside face, including stuffing-box for the valve-spindle, and bore for same being turned to finished dimensions at this setting. It was now removed from the chuck, and mounted on a mandrel made to fit the bore and stuffing-box, and the back turned with a spigot (not shown in sketch), which fitted the bore of the valve-body. All holes in the cover, including stud-holes for gland, were then marked off and drilled, and where necessary, tapped.

The columns supporting the bridge containing the nut for the valve-spindle were then made and fitted; the bridge was then made, tapping the hole for valve-spindle first, and then machining both faces of the bridge whilst mounted on a suitable screwed mandrel. Holes for the supporting columns were then carefully marked off, and more carefully drilled, as any error here would have upset things pretty effectively. Suffice to say that luck again held good, and when the valve spindle, gland, and the rest were assembled, it left nothing to be desired.

The valve, *E*, Fig. 22, was next made, and as no suitable milling-cutter was available for milling the wings of the valve, it was made from the solid. Three holes were drilled of equal depth, and equally spaced around the centre in the end of a piece of round bronze, the metal left between the holes forming the three wings of the valve. The

In the meantime, the slogan must be "Don't forget the drains" when raising steam.

As the cylinders are some distance from the bed of the engine, due to the feet on which they stand, it was not convenient to screw the drains directly into the cylinder walls; so adaptors were made with union nuts and brought down through the bedplate; this enabled the drain valves to be mounted underneath the bedplate where it would be more convenient to fit the actuating gear.

It will be seen on reference to Fig. 23, that the body of the valve is built up, and that the valve and its seating are removable. In construction, after roughly boring the body, the internal bore was finished to size and shape by means of a D-bit made to the finished size of the bore. This method ensured that all four bodies were alike, internally at any rate, so that the four valve seatings and valves could also be made alike. Other than the valves themselves the only joint which need be steam-tight is where the seating beds on the inside of body (see X, Fig. 23). After all four valves and seatings

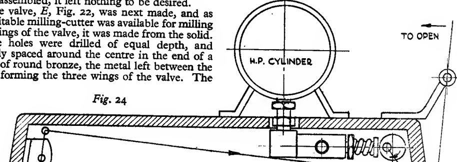


Fig. 24

rod with the holes in was now truly centred in the chuck and the surplus metal turned off, leaving the valve with the three wings. The head of the valve and the seat were turned down to the requisite diameter, and the seat turned to 60 deg.; the whole was then parted off, and the valve was complete excepting for the grinding-in. As the steam from the boiler enters under the valve, and the spindle is long enough to allow the valve to open fully, but not far enough to leave its guide, no connection between the valve and spindle is provided; in other words, there is no horseshoe on the back of the valve.

Fig. 23 illustrates two views of the cylinder drains and a portion of the actuating gear; it may be stated here that if the job were to be done again, the drain valves would be designed differently; as at present designed, any excess pressure in the cylinders due to the presence of water would tend to close the valves, and it is considered preferable to arrange so that excess pressure would open them. At the time these drains were being made, it was intended to fit relief-valves in each cylinder cover; that, however, has not been done, although the idea still lingers, and may one day be put into practice.

had been made and fitted they were each screwed tightly into their respective bodies, and the position of the outlet marked on the side of the seating. The metal was then cut away at this position until the inside bore of the seating was reached; the sketches will make this clear.

The end of the valve spindle is screwed to take the steel cap holding the spring, the function of which is to ensure valve closing when the pressure from the eccentric in the operating-gear is removed. In the case of the H.P. cylinder, the steam pressure would take care of that; but, in the L.P., when working on a vacuum, the tale may be a different one.

Reference to the photograph taken from the front side of the engine shows to the right of the regulator valve are situated three levers. The two nearer the regulator valve, control the drains. Fig. 24 is a diagram showing how the levers are coupled up; each lever controls the drains to one cylinder. The diagram also illustrates the method adopted to couple drain valves to cylinders. The third lever controls the L.P. impulse-valve, which will be described later.

(*To be continued*)